Emission of N_2O & NH_3 from NY Dairy Farms: Measurement, Modeling & Extension

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Project components: research

- 1) Measure emissions from NY dairy farms
  range of manure management practices, including those recommended for water quality and/or odor mitigation
- 2) Farm-scale model: simulate emissions, assess impacts of mitigation measures

Project components: outreach

- 3) Publications and training to raise awareness and facilitate change through PRO-DAIRY network
- 4) Ecohydrology & nutrient management course modules on dairy farm N emissions

Context: Dairy in NY & the NE

State/Region	Milk 10^9 lb	Farms	Cows 10^3 head
1) California	36.5	2,030	1,725
2) Wisconsin	22.0	15,570	1,241
3) New York	11.5	6,630	655
4) Penn	10.0	8,720	562
All NE	27.6	18,610	1,557
Total US	170.8	66,830	9,010

Dairy factors in NY & the NE

1) Nutrient flows

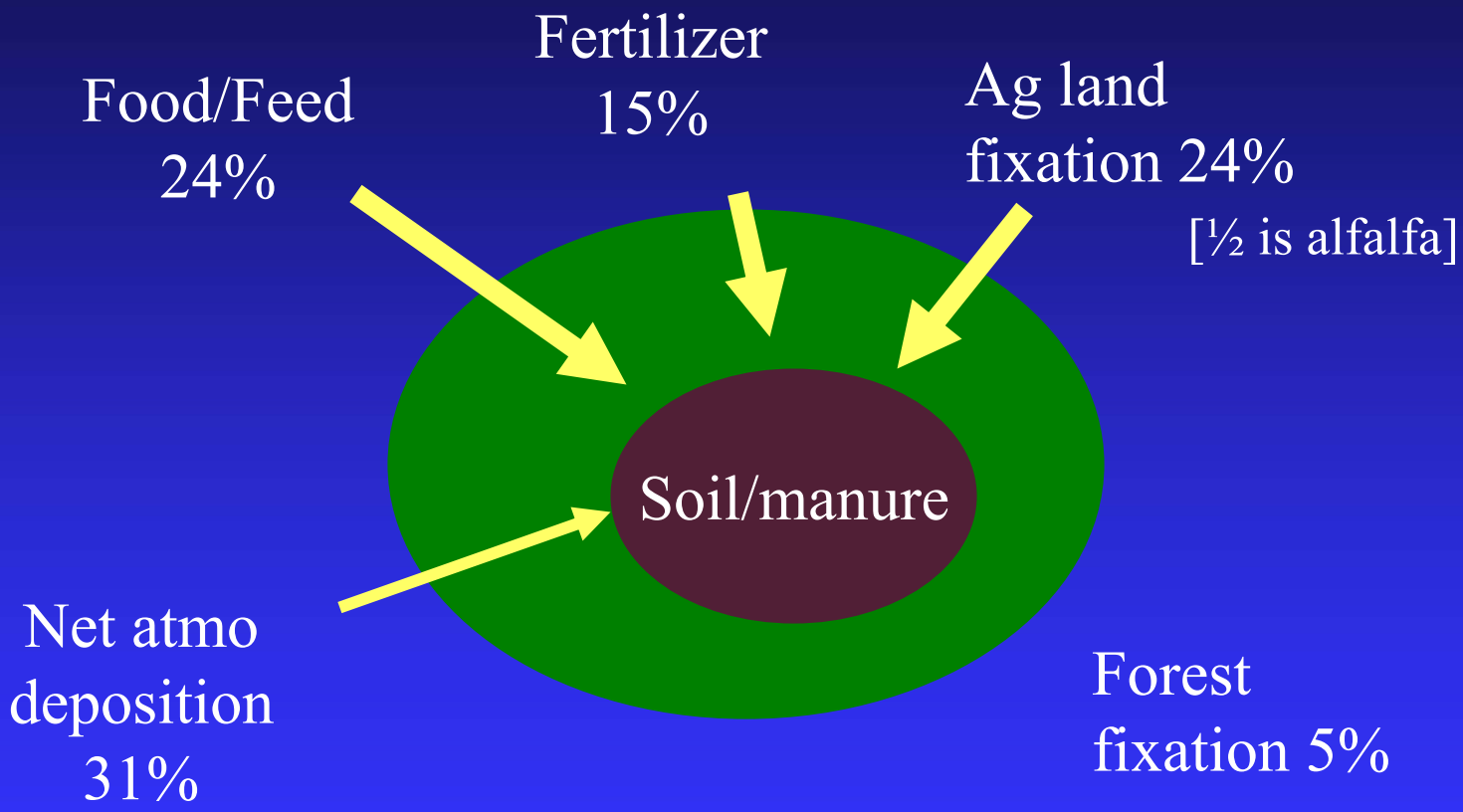
2) Development pressure

3) Hydrology

1) Nutrient flows: N budgets

- Substantial feed importation
  - Off-farm feed purchases account for up to 1/3 of gross income
- Substantial agricultural N_2 fixation
- BOTH exceed fertilizer imports
  - Manure therefore significant

NE Regional N budgets (Boyer; Van Breemen 2002)



2) Development pressure

- Many non-farm neighbors: pressure for odor control practices which may exacerbate N_2O losses

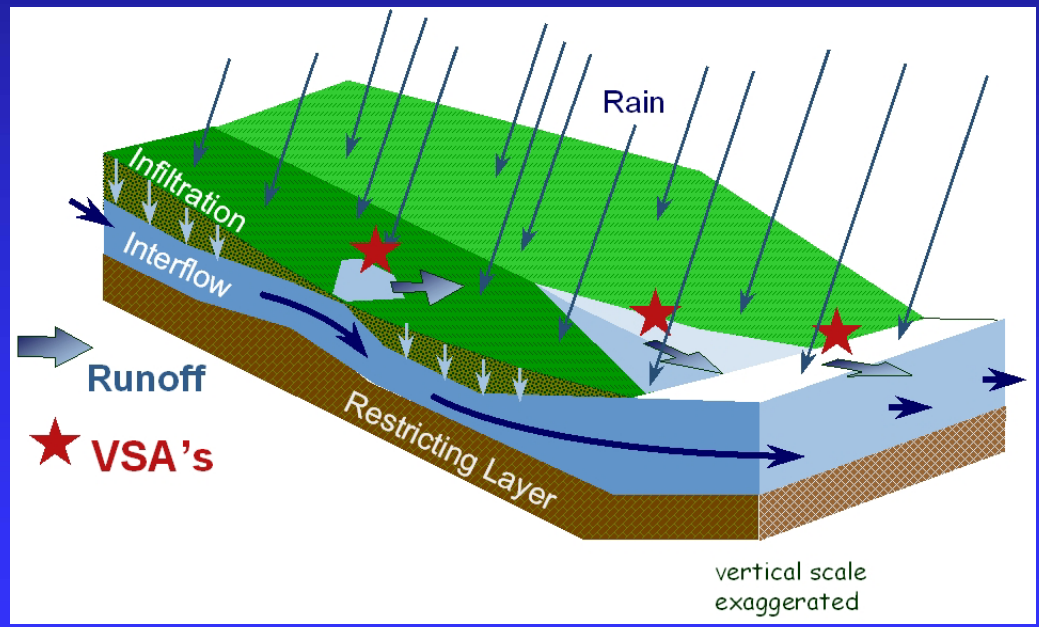
- Pressure to increase herd size relative to land base

Lancaster Co, PA

3) Hydrology

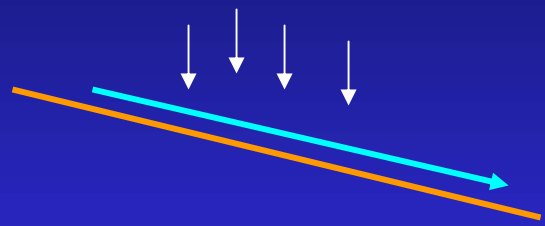
- Landscapes in NE characterized by rolling terrain and thin soils with restrictive layers

Saturation and interflow differ from conventional models

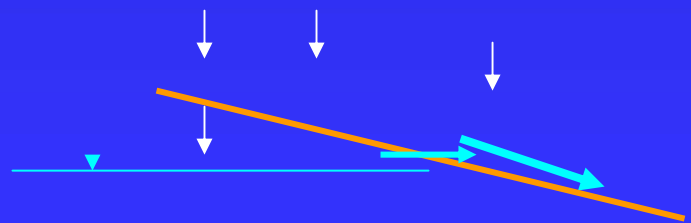


Runoff & saturation

Hortonian concept runoff occurs when rainfall intensity exceeds the soil's infiltration capacity – true for many locations



But in NE and other humid areas intensity *rarely exceeds* infiltration capacity. Runoff occurs when soil saturates to the surface. Saturated area varies with time, hence term *variable source area.*



Variable Source Area (VSA) hydrology

saturated areas (red) vary with topography and time:

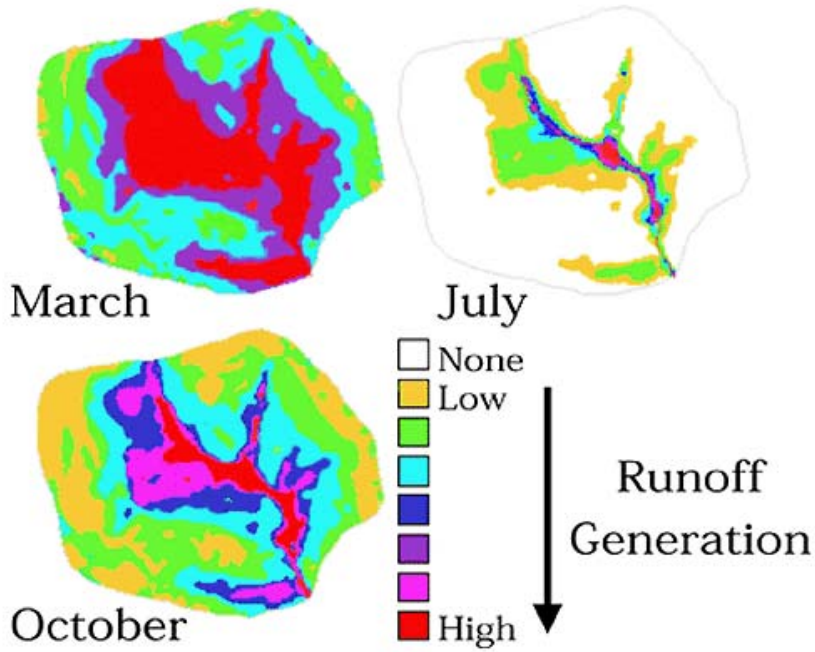


Figure 4: Probability map of runoff generation from saturated areas on a 100 ha farm in the Catskill Mountains

VSA hydrology

Spread here?

Or here?

Practices to avoid losses may be counterintuitive

- Nutrient flows

  significant feed N (and P) importation

- Development pressure

  higher cow densities; odor control practices

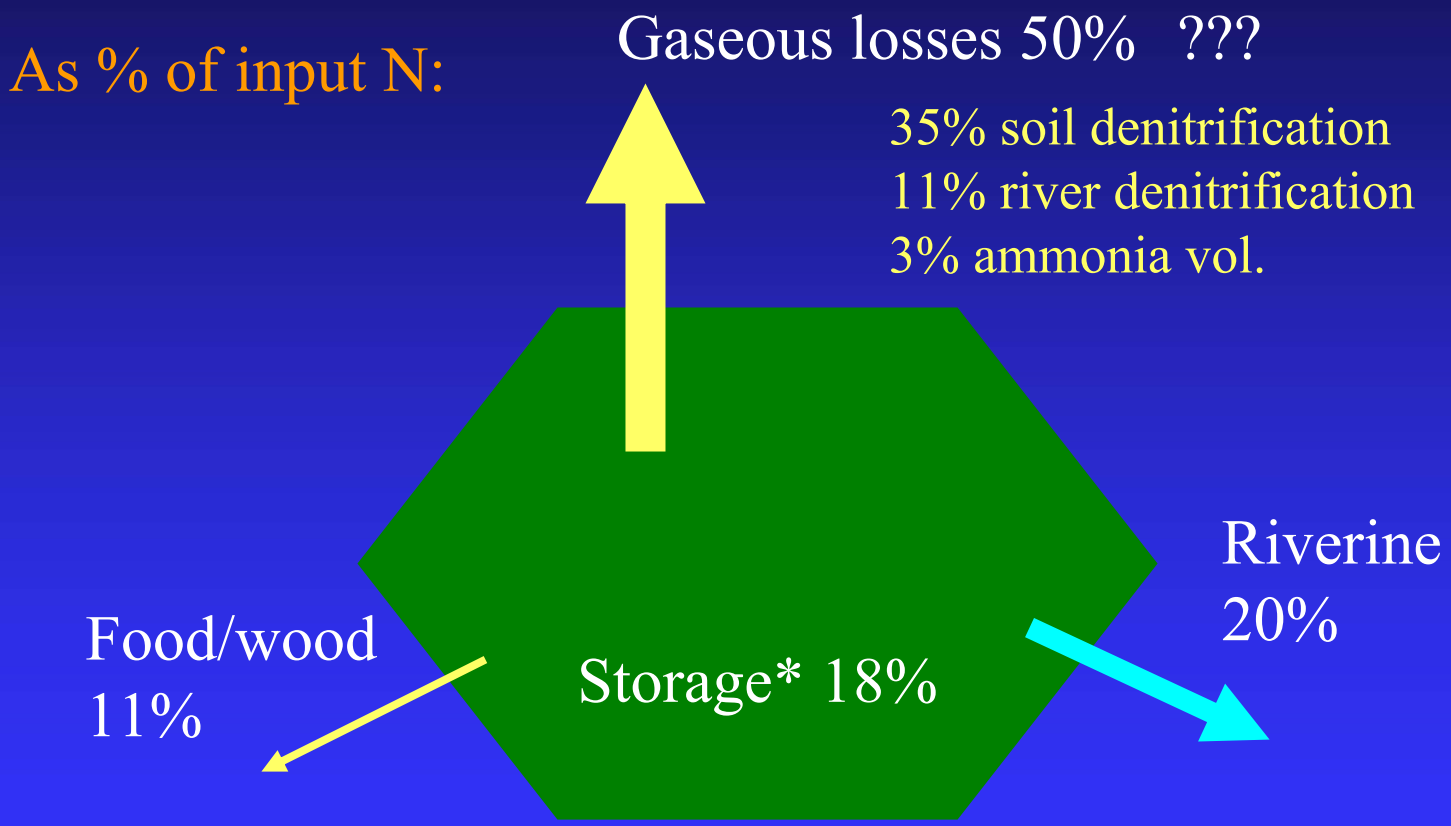
- Hydrology

  saturation and interflow

Combine for significant denitrification potential?

NE N budget: storage and losses

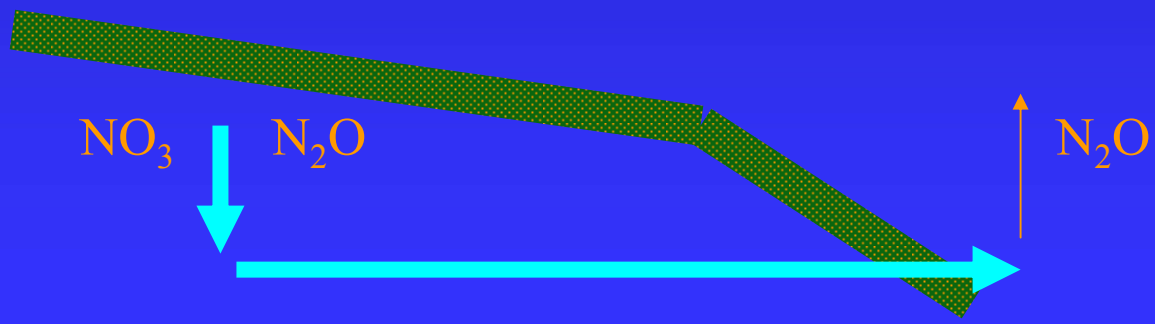
As % of input N:



Van Breemen et al. 2002

Landscape-scale approach

- To capture field- and farm- scale hydrologic processes
- Beauchamp 1997: Denitrification likely *greater* than soil surface fluxes indicate due to interflow/groundwater transport of NO_3 and N_2O



Project status

- Fieldwork: 9 month delay from initial plan
  - PI ✋ equipment changes
  - analyzer/micromet equipment manufacturer lead time
- Lab scale work on N_2O and NH_3 loss potentials from fresh manure

Campbell Scientific TGA system

- Focus on N_2O
- Simultaneous CO_2 and water vapor sensors
  - Concurrent N_2O / CH_4 capability with slight loss of sensitivity
- Complete micromet and logging system

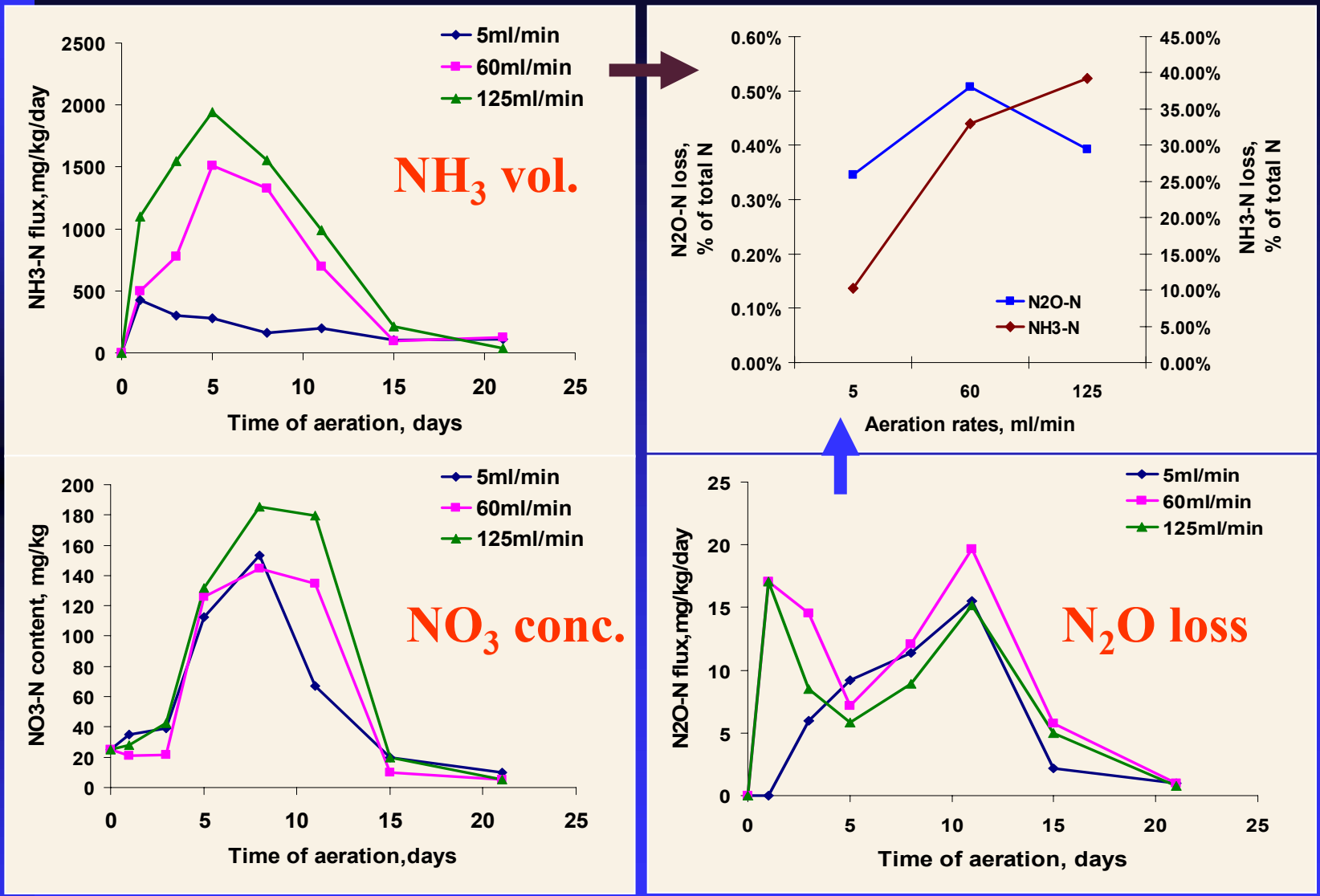
Farm-scale testing

6 large commercial farms to select from with a range of manure management practices:

Key: timing & placement

Marina Molodovskaya:

- Bench-scale incubation work to determine bounding estimates of potential NH_3, denitrification and N_2O losses from fresh dairy manure
- Corresponds with short-term manure P availability testing

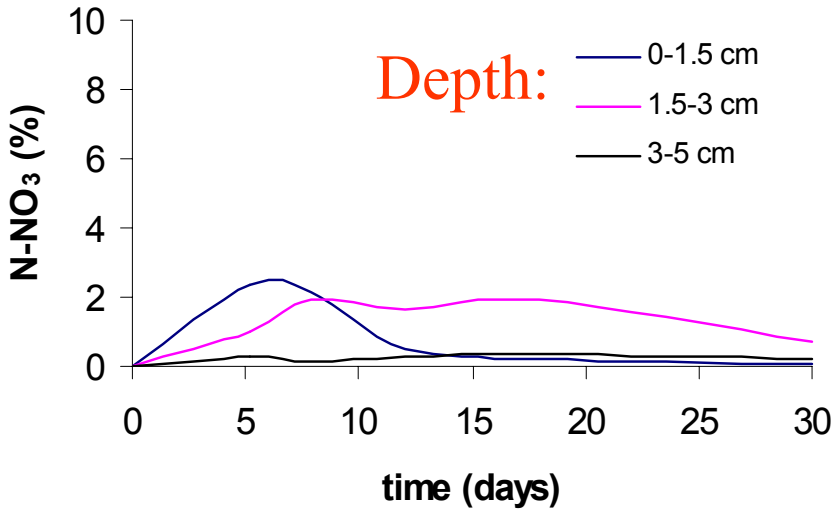

5ml/min
60ml/min
125ml/min
NH3-N flux,mg/kg/day
Time of aeration, days
NH3 vol.
N2O-N loss, % of total N
NH3-N loss, % of total N
N2O-N
NH3-N
Aeration rates, ml/min
NO3-N content, mg/kg
Time of aeration,days
NO3 conc.
N2O-N flux,mg/kg/day
Time of aeration, days
N2O loss

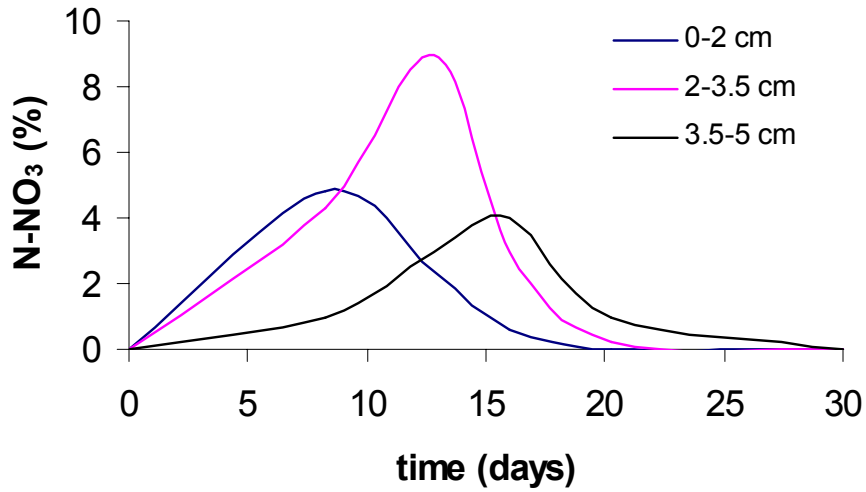
Olga Singurindy:

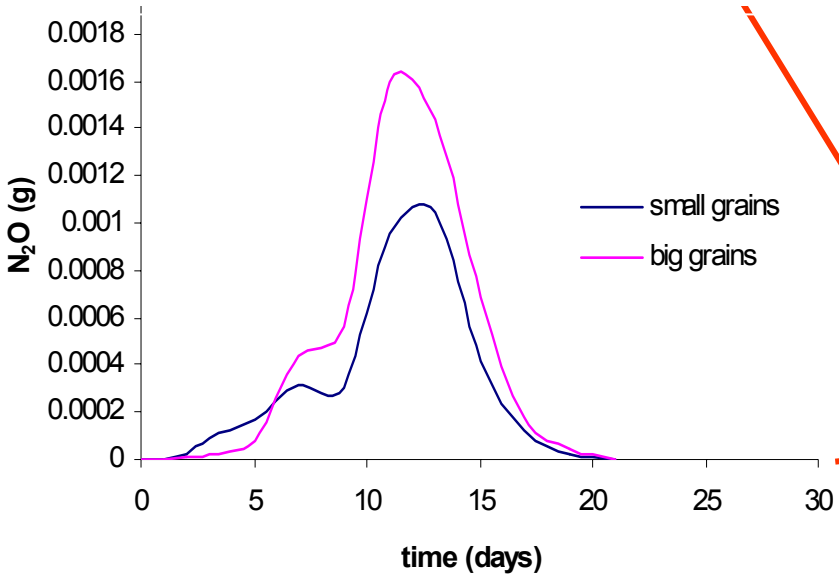
- NH_3 and N_2O losses from urine-affected soils as a function of saturation and soil grain size (texture)

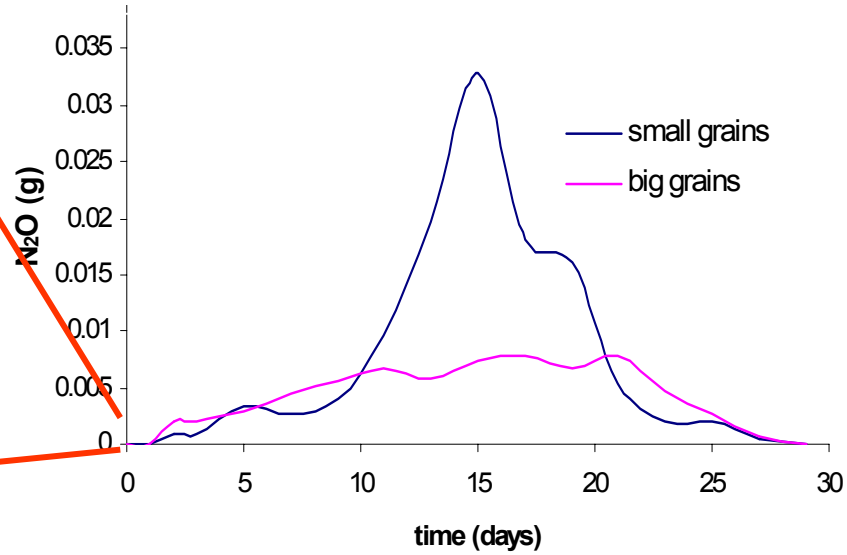
30% water-filled porosity

60% water-filled porosity







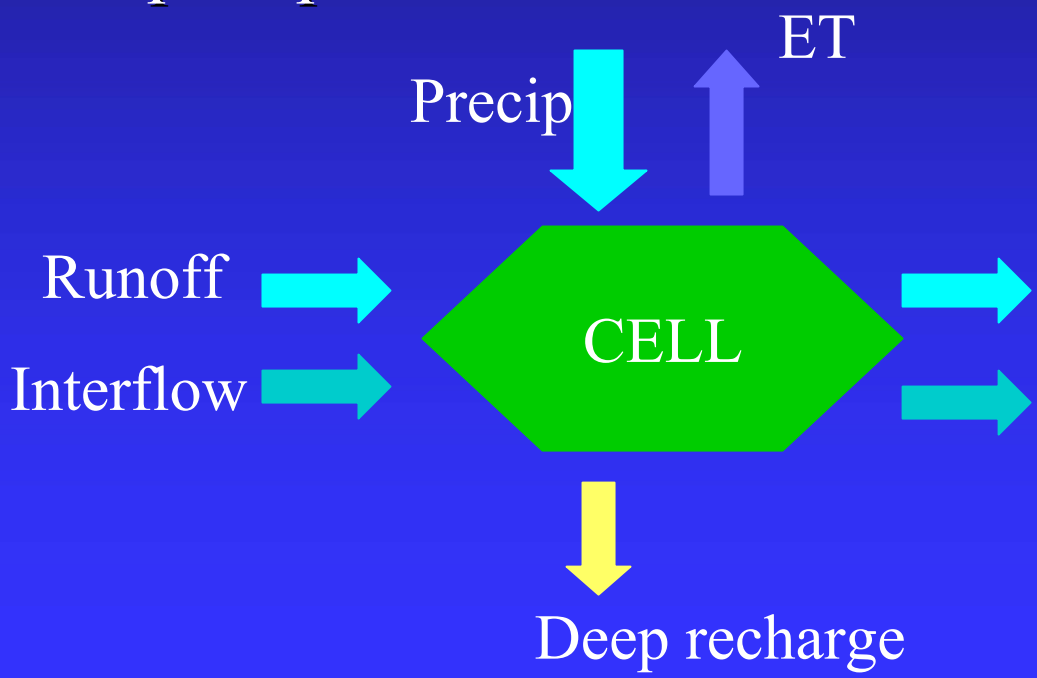


Plans

- Deploy TGA field system this summer
  - Incorporate NH_3 capability
- Data collection at farm scale
- Hydrologic modeling: SMR of farms
- Combining hydrologic/N flux modeling
- Outreach components

SMR: Soil Moisture Routing model

- Distributed model that calculates a water budget for each cell in a landscape on a daily basis
- Computationally intensive; uses soil characteristics, elevation and precip datasets



Questions?

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